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NOVEMBER 1984 NUMBER 195

MONTHLY REPORT

ON THE NUCLEAR FUEL MARKET

NUEXCO

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MONTHLY REPORT ON THE NUCLEAR FUEL MARKET

November 1984 No. 195

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PRICING
Natural Uranium and Conversion 1
Enriched Uranium and SWUs 2

CURRENT MARKET DATA
Nuexco Market Data Table 6
Prices Expressed in Selected Currencies 7
Recent Transactions 9
Supply and Demand Tables 11

ANALYSIS AND COMMENTARY
Optimum Tails Assay, Part I 16

RECENT DEVELOPMENTS
Australia 20
South Africa 21
United States 22

HISTORICAL MARKET DATA
Graph of Exchange Value and Transaction Value 23
Historical Exchange Value, Transaction Value and Conversion Value ... 24

GOVERNMENT STATISTICS
Australia and Canada 25
South Africa and United States 26

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To Our Readers

We are pleased to announce that Mr. **Ralph O. Smith** has joined Nuexco as a representative. Mr. Smith retired on November 1, 1984 from his position as vice president of Purchasing and Materials Management at Northeast Utilities Service Company and he brings valuable expertise to the Nuexco staff.

Mr. Smith was graduated from Purdue University in 1950 with a bachelor of science degree in electrical engineering, beginning his utility career at the Connecticut Light and Power Company at that time. In 1960 he began a career in purchasing that led in 1976 to his becoming Director of Purchases for the Northeast Utilities Service Company (NUSCO). He became a vice president in June 1981. Mr. Smith is a current member of the American Nuclear Society as well as the National Association of Purchasing Management, Inc. (NAPM); in addition, he is on the Executive Committee of the Public Utility Buying Group of NAPM. He received the Cheshire (Conn.) Chamber of Commerce's Outstanding Service Award in 1976.

* * *

Nuexco will host a hospitality suite during the Atomic Industrial Forum's Annual Conference in Washington, D.C., November 11–14. We look forward to seeing you there.

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NATURAL URANIUM AND SECONDARY MARKET CONVERSION

The **Exchange Value** as of October 31, 1984 is **$16.00** per pound U_3O_8, down $1.50 since last month. **Active supply** of natural uranium (U_3O_8 and UF_6) for spot or near-term delivery totals **5,450,000** pounds U_3O_8 or equivalent UF_6, down 40,000 pounds since last month. The corresponding figure for **active demand** is **1,275,000** pounds, up 320,000 pounds. The spot and near-term **supply-demand ratio** fell to **4.3:1.**

The *Current Market Data* section of this Report lists eleven uranium sales transactions, involving a total of approximately 1,600,000 pounds equivalent U_3O_8. Four of those sales involved natural UF_6, and one involved enriched uranium. All of the transactions reported this month involved deliveries before 1986, and five met the criteria for inclusion in the current Transaction Value calculation.

The **Transaction Value** as of October 31, 1984 is **$16.05** per pound U_3O_8, down $0.50 since last month. The current Transaction Value includes 10 transactions involving a total of 2.7 million pounds U_3O_8 or equivalent UF_6 and covers a period of 5 months.

The **Loan Use Charge Rate** as of October 31, 1984 is **6 percent** per annum, unchanged since last month in a nearly dormant market.

* * *

October's nine percent decline in the Exchange Value was a direct result of the persistent excess of supply over demand characteristic of the current uranium market. That factor manifested itself in two distinct ways.

1. Several sellers made offers well below last month's Exchange Value.

2. Generally, offers in the $16.00–16.50 range still failed to interest buyers.

In this nearly saturated market, almost all demand that does exist is discretionary, as opposed to fundamental. Thus, it has become necessary for sellers to offer especially attractive prices and terms to stimulate interest.

Low market prices and a lack of substantial demand have dissuaded several potential sellers, particularly those producers and users having large, unneeded inventories, from seriously entering the market. Most of the uranium transactions reported this month involve almost immediate deliveries. The frequency of nearer-term transactions in recent months may be attributed to several factors.

1. Having completed their analyses of DOE's offer of the Utility Services enrichment contract (USEC), certain utility fuel managers could turn their attention to the purchase of feed material for the purpose of immediate forward supply.

2. The approach of the end of secondary market in FY85 SWUs may have stimulated some utilities to obtain inexpensive uranium concentrates and proceed with enrichment as quickly as possible.

3. Several of the reported transactions occurred in mid-1984, but were not finalized until this month.

With buyers firmly resisting any upward movement of prices, sellers of spot or near-term material generally will come from three categories:

1. Producers having lower production costs who, due to cash needs or other financial considerations, choose to compete more vigorously for the limited available business;

2. Inventory holders that expect prices to drop lower soon;

3. Inventory holders that have overriding reasons for liquidating, regardless of market conditions.

* * *

The **Conversion Value** is **$1.00** per pound U in UF_6, unchanged since last month. Active supply of secondary market conversion services for delivery within three years amounts to 1.2 million pounds U in UF_6. No active secondary market conversion demand for delivery within three years, and no secondary market conversion transactions, are reported.

The sale of natural UF_6 to buyers that prefer natural uranium concentrates often requires sellers to discount their offering prices substantially, primarily by pricing the conversion services contained therein virtually at zero. October uranium sales supported that premise, as conversion was usually free for buyers of natural UF_6. Nevertheless, any buyers seeking to purchase conversion services on the secondary market would be facing prices of approximately $1.00 per pound U in UF_6.

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PRICING

ENRICHED URANIUM AND SWUS

The Nuexco **SWU Values** as of October 31, 1984 are unchanged from last month:

1. For **DOE origin** and a tails assay of 0.30 weight-percent U_{235}:
   a. For FY85 delivery, $115 per SWU;
   b. For FY86 delivery, $20 discount from the USEC base price on delivery;
2. For **non-DOE origin:**
   a. For delivery within approximately 15 months, $90 per SWU;
   b. For delivery in CY86, $98 per SWU.

Eight secondary market SWU transactions are reported, involving 620,000 SWUs. Active secondary market SWU supply amounts to 650,000 SWUs, while active demand totals 170,000 SWUs.

* * *

Secondary SWU market activity for several months has been overshadowed by DOE customers' analysis of the USEC offer, reactions to it, and negotiations of conversion terms. Because October 1 was the nominal deadline for conversion to the USEC, almost all nuclear utilities have by now completed their basic long-term planning for enrichment services. Most have signed long-term contracts with one or more primary suppliers that will match SWU deliveries closely to reactor requirements. As a result, many fuel managers will be able to reduce their inventory levels and fuel costs for the long term.

Competition in both primary and secondary markets has been the principal driving force behind the development of contract terms more favorable to utilities. Nevertheless, most buyers' recent contract decisions have been heavily influenced by national political concerns. For example, almost all US utilities, and all of DOE's Japanese customers, have signed new contracts with DOE. The French, Italians and Belgians will receive most of their requirements from Eurodif; and most deliveries to British, Dutch and German utilities will come from Urenco.

In a few cases, European buyers signed the USEC against their apparent national interests. This was the case most pointedly with ENUSA, a Eurodif shareholder, which converted AFCs for nine units to the USEC. The dominant motivation was economic, in that DOE gave ENUSA favorable terms for assigning or otherwise reducing inventories held at DOE. Also, certain German utilities signed new contracts with DOE under favorable terms.

Last month, Report 194 discussed DOE objectives and marketing strategy. It also presented a partial list (Table 1 on page 3) of DOE sales losses from contract cancellations, using DOE data (as of March 1984) presented to Congress in August. Certain portions of the data require further explanation:

1. ENUSA sent DOE notices of cancellation of its AFC contracts from 1992 onward (i.e., with zero termination charges). One notice, covering the bulk of ENUSA's reactors, was sent in 1983. The second notice, covering the balance of ENUSA's AFC contracts, was sent in May 1984. Those notices were rescinded as part of ENUSA's negotiations with DOE to convert to the USEC. Recently, DOE released a list of non-US customers that converted to the USEC that indicated ENUSA had converted to the USEC at 100 percent of requirements. That is misleading, in that it ignores the fact that Eurodif will cover 30 percent of requirements for DOE-supplied units when the DOE portion drops to 70 percent at a future date. It also ignores the fact that Vandellos 2 and Trillo 1 will be supplied by Eurodif, with some USSR deliveries.

2. Leibstadt and Goesgen, both undecided as to replacement supplier as of the date of the table (Report 194, page 3, Table 1), later signed contracts with Cogema.

The following is a review of the current status of enrichment services coverage by primary suppliers, now that almost all conversions to the USEC are known. Table 1 summarizes the data.

Europe

Belgium—Synatom owns 50 percent of SOBEN (Belgium Enrichment Group), which owns 11.1 percent of Eurodif. Having canceled future deliveries under its 3.5-year Requirements contracts (DOE) for Doel Unit 1, Doel Unit 2 and Tihange Unit 1, Synatom is covered 100 percent by Eurodif enrichment. That amounts to 3,450 MWe (5 units) in 1984 and will grow to 5,450 MWe (7 units) by 1990. The two additional units will also be covered by Eurodif.

Finland—TVO and IVO will accept all of their enrichment needs from the USSR.

France—Cogema, the principal shareholder in Eurodif, supplies all enrichment services for Electricite de France (EDF); both are state-owned companies. All but two units receive enrichment from Eurodif; the two exceptions are Fessenheim Unit 2 and Bugey Unit 3, which are covered by AFC contracts with DOE. As of November 1, 1984, Cogema had not signed the USEC.

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Table 1

ENRICHMENT SUPPLIERS' CURRENT MARKET SHARES

	Nuclear Electric Generating Capacity Estimate for Reactors Using Enrichment Services			Enrichment Coverage by Primary Suppliers[2], [3] (market share in percent)				
	No. of Operational Reactors	MWe	Capacity as Percentage[2] of Total	DOE	Eurodif	Urenco	USSR	None
Europe								
Belgium	5	3,450	2.2	0	2.2	0	0	0
Finland	4	2,220	1.4	0	0	0	1.4	0
France	31	28,050	17.6	note 4	17.6	0	note 5	0
Germany (FRG)[3]	14	13,567	8.5	2.7	0.5	3.3	1.5	0.6
Italy	2	1,135	0.7	0	0.7	0	0	0
Netherlands	2	495	0.3	0.3	0	0	0	0
Spain	6	4,270	2.7	2.7	0	0	0	0
Sweden	10	7,325	4.6	4.4	0	0	0	0.2
Switzerland	5	2,882	1.8	1.4	0	0.2	0	0.2
United Kingdom[3]	7	4,350	2.7	0	0	2.5	0.2	0
Yugoslavia	1	615	0.4	0.3	0	0	0	0.1
Total	87	68,359	42.8	11.8	21.0	6.0	3.1	1.1
Far East								
Japan[6]	28	19,829	12.4	12.4	note 7	0	0	0
Korea	2	1,185	0.7	0.7	0	0	0	0
Taiwan	5	4,017	2.5	2.5	0	0	0	0
Total	35	25,031	15.7	15.7	0	0	0	0
Other Countries								
Brazil[8]	1	626	0.4	0	0	0	0	0.4
India	2	400	0.2	0	0.2	0	0	0
South Africa[8]	1	922	0.6	0	0	0	0	0.6
Total	4	1,948	1.2	0	0.2	0	0	1.0
United States	80	64,458	40.3	31.8	1.0	0.4	0	7.1
World Total	206	159,796	100.0	59.3	22.2	6.4	3.1	9.2

[1]While SWU demand is related to generating capacity, reactors of the same size can have different SWU needs, depending on type, reload cycle, and various other physics factors. Nevertheless, in the aggregate, generating capacity is a useful indicator of *relative* market size. Thus, Belgium for example, having 2.2 percent of the world's current operational nuclear generating capacity, represents *approximately* 2% of the world market for SWUs.

[2]Columns and rows may not add to totals, due to independent rounding. All percentages refer to status as of 1984.

[3]Reactors covered by more than one supplier were arbitrarily weighted by Nuexco.

[4]As of November 1, 1984, Cogema had not signed the USEC.

[5]Cogema contract with USSR covers small percentage of SWU requirements.

[6]All Japanese reactors currently operating are supplied mostly by DOE. Some converted to the USEC at 70 percent. The effects on Japan's large advance purchase of DOE SWUs are not yet known.

[7]Several Japanese utilities have non-DOE contracts in addition to their DOE contracts.

[8]Brazil and South Africa's enrichment needs are being filled from inventory. Plans are to supply future enrichment needs domestically.

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Cogema also has a contract with the USSR for a small fraction of EDF's future needs.

Germany (Federal Republic)—The nine FRG utilities operating nuclear power plants have among them thirteen units in commercial operation and nine under construction or in the startup/power ascension process. Urenco will supply the bulk of the long-term requirements for at least 14 of the 22 units. For the nearer term, seven units are covered by DOE contracts (two Requirements, one AFC, and four USECs): nine are covered by Urenco, five by the USSR, and one by Eurodif. One of the units covered by the USEC, HKG 300 (a thorium high-temperature reactor), has already enriched its inventory (93 percent U_{235}), so it will not be a market factor for the near term.

Italy—ENEL, a Eurodif shareholder, has Eurodif coverage for all reactors operating or under construction.

Netherlands—PZEM converted its abbreviated 5-year Requirements contract to the USEC for its only commercial-sized operating unit, Borssele. However, Urenco will assume deliveries later in this decade.

Spain—ENUSA, a Eurodif shareholder, converted to the USEC all nine of its AFCs, including two for the indefinitely delayed Lemoniz units. ENUSA had given notice to DOE for termination of its AFCs after 1992, but in negotiations late this summer, the two parties reached agreement on terms for conversion. Eurodif will furnish enrichment for Vandellos Unit 2 and Trillo Unit 1, and may supply some portion of ENUSA's other requirements at a later date. ENUSA also has a small contract with the USSR.

Sweden—OKG did not convert to the USEC, so Oskarshamn Units 1 and 2 continue to be supplied by 3.5-year Requirements contracts. The USSR will provide enrichment for a third unit due to begin operation in 1985, Oskarshamn 3. SSPB, which operates both the four-unit Ringhals station and the three-unit Forsmark plant, will continue to be covered by five AFC and two 3.5-year Requirements contracts. Sydkraft converted its Requirements contracts (one 3.5-year and one 5-year) to the USEC. The Swedish utilities will take delivery of a large number of SWUs from Eurodif later in this decade under a contract with Eurodif's Italian shareholders.

Switzerland—BKW converted a 3.5-year Requirements contract for its operating unit (Muehleberg) to the USEC, and also the AFC contract that covered the planned Graben unit. KKL converted its AFC to the USEC for deliveries until a contract with Cogema commences later in this decade. KKG signed a long-term contract with Cogema to succeed its AFC. Kaiseraugst is also covered by Eurodif. NOK has one contract with Urenco, and as of November 1 was not known to have converted its 3.5-year Requirements contract to the USEC.

United Kingdom—Both CEGB and SSEB are covered primarily by Urenco, with a portion of requirements coming from the USSR.

Yugoslavia—Krsko signed the USEC for its only unit.

Far East

China will not need any enrichment before 1990. Commercial arrangements have not yet been established for future enrichment needs. Some observers think that China has stockpiled substantial enriched uranium from their own process.

Japan—All DOE customers converted to the USEC, with three or four utilities electing 70-percent coverage. The Japanese situation is complicated by several factors:

1. Large SWU commitments associated with advance purchases made years ago. Scheduled deliveries over the next five years amount to approximately 4,000,000 SWUs.

2. Substantial purchases from Eurodif that are not needed to supply reactor requirements.

3. Inventories arising from past purchases under AFCs for reactors that are not due to start operating in this decade. Terms of conversion to the USEC, especially insofar as they allow the substitution of inventories, will be critical to the future SWU supply situation in Japan.

Korea—Two operating units, plus four units scheduled to begin operating by 1990 were covered by AFC contracts; all were converted to the USEC for 100 percent of requirements. Two other units under construction (Ul Jin-Kun 1 and 2) will be covered by Eurodif.

Taiwan—Taipower converted one 5-year Requirements contract (Chin-Shan 1 and 2) and four AFCs to the USEC. Yenliao 1 and 2 will be covered by Eurodif.

Other Countries

Brazil had a DOE 5-year Requirements contract for Angra dos Reis Unit 1, but it has been suspended. Nuclebras (Empresas Nucleares Brasileiras S.A.), in conjunction with Kraftwerk Union (KWU), is developing a domestic enrichment capability using the Becker jet-nozzle separation process. A demonstration plant with a capacity of 200,000 to 300,000 SWUs per year is under construction at the Resende fuel cycle complex. Once scheduled to start in 1983, the plant has been delayed repeatedly.

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India—DOE reached an agreement with India's Department of Atomic Energy to terminate its DOE contract, and France agreed to supply enriched UF_6 from Eurodif until 1993. Only the two 200-MWe Tarapur units use enriched uranium; the other four reactors (three operating, one under construction), being Pressurized Heavy Water Reactors (PHWR), use natural uranium.

Mexico—Anticipating Mexico's acceptance of the USEC, DOE allowed the Comision Federal de Electricidad (CFE) to terminate its AFC contracts due to overcommitment. CFE has since signed the USEC for 100 percent of its requirements. However, operation of neither Laguna Verde unit is imminent, so CFE's enrichment demand is not reflected in Table 1.

South Africa—DOE suspended two AFC contracts the Electric Supply Commission (ESCOM) had held since 1974. The Nuclear Nonproliferation Act of 1978 had prevented the export of uranium enriched under the contracts because South Africa had not accepted full-scope safeguards. The suspension was requested by the State Department after South Africa's Atomic Energy Corp. agreed that it would require safeguards as a condition of exporting nuclear material or technology. Having purchased at least enough enriched uranium to supply the initial cores for its two Koeberg units, ESCOM believes it has enough forward supply of enriched uranium to last until a domestic enrichment plant is operating. (The Atomic Energy Corp. is developing the Helikon jet-nozzle process for an enrichment plant.)

United States

Several US utilities rejected the USEC. Boston Edison signed a long-term contract with Urenco; Yankee Atomic, Maine Yankee and Vermont Yankee signed contracts with Cogema. American Electric Power (AEP) and Pacific Gas & Electric have chosen not to convert. Sacramento Municipal Utility District (SMUD) has indicated it also will not convert to the USEC. Taking into account the utilities that have converted at less than 100 percent of requirements, approximately 79 percent of US installed capacity is covered by DOE; two percent by Eurodif; one percent by Urenco; and 18 percent is uncommitted. The 18 percent of the US market that is presently uncommitted amounts to approximately seven percent of the world market for enrichment services.

Conclusion

Conversions to the USEC and some penetration of the US market by non-DOE primary suppliers have left DOE with approximately 60 percent of the current worldwide market for enrichment services (Table 1 gives a breakdown). Eurodif holds 20 to 25 percent, Urenco holds 5 to 10 percent, and the USSR holds up to 5 percent. The uncommitted portion amounts to approximately nine percent of the market, almost all in the USA.

In a number of instances involving both Far East and European customers, the announced percentage of requirements to be covered by DOE is misleading. Several utilities for which DOE claims 100-percent coverage have one or more reactors that will, in fact, receive little or no enrichment from DOE. Thus, by defining requirements as relating only to those reactors it now covers, DOE implies a situation quite different from reality. Similar situations exist as a consequence of the various concessions DOE has granted as inducements to maintain market share.

DOE has been careful not to reveal the appendices of signed USECs, even going so far as to refuse Representative Richard Ottinger's (D., N.Y.) request for copies of the contracts. DOE has offered various justifications, such as customers' requests for confidentiality or DOE's desire to avoid giving their foreign competitors any advantage with those customers that have not yet signed. The most important reason, however, is DOE's fear that any customer learning of a concession made by DOE to another customer would insist on reopening negotiations to obtain the same concession(s). Even after DOE's November 17 target date for releasing the data, there is no certainty that DOE will release the appendix details.

Next month's Report will analyze the balance of SWU supply and demand and its effect on the market; that analysis will incorporate Nuexco's knowledge of the terms and conditions that applied to individual customers' conversions to the USEC. It will also incorporate Nuexco's projections of buyers' decisions on alternate SWU supplies, both for the fractions of requirements their current USEC allows to be purchased on the open market and for future years, when they may change the fraction.

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CURRENT MARKET DATA

October 31, 1984	Market Values	Active Supply[1] (thousands)	Active Demand[1] (thousands)
EXCHANGE VALUE	**$16.00**/lb. U_3O_8	5,450	1,275
CONVERSION VALUE	**$1.00**/lb. U in UF_6	1,225	0
SWU VALUES		650	170
DOE origin, 0.3 tails assay			
FY85 delivery	**$115**/SWU		
FY86 delivery	**$20** discount/SWU		
non-DOE origin, delivery within 15 months	**$90**/SWU		
non-DOE origin, CY86 delivery	**$98**/SWU		
LOAN USE CHARGE RATE	6%/annum	0	0

TRANSACTION VALUE	$/lb. U_3O_8	Millions of Pounds	Number of Transactions	Number of Months
	16.05	2.7	10	5

[1]Supply and demand tables in the *Current Market Data* section of this Report detail the numbers for each category. Quantities of SWUs (Separative Work Units) are not referenced to a particular origin.

DEFINITIONS

1. The **Exchange Value** is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the date indicated.
2. The **Conversion Value** is Nuexco's judgment of the price at which spot and near-term transactions for significant quantities of conversion services could be concluded in the secondary market as of the date indicated.
3. The **SWU Values** represent Nuexco's judgment of the price at which transactions for the sale of significant quantities of SWUs of stated origin for delivery in the specified time period could be concluded as of the date indicated.
4. The **Loan Use Charge Rate** is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the date indicated.
5. The **Transaction Value** is a weighted average price of recent natural uranium sales transactions. The calculation is based on prices paid in:
   a. Transactions closed within the previous three-month period for which delivery is scheduled within one year of the transaction date;
   b. At least ten transactions;
   c. Transactions involving a sum total of at least 2 million pounds U_3O_8 equivalent.

   The sample time is extended as necessary to include these minima. Other currencies are converted to US dollars using conversion rates in effect on or near the transaction date.

DERIVATIONS AND COMMENTS

1. All Market Values are based on:
   a. Data from recently completed transactions.
   b. Data from pending transactions.
   c. Firm bids to buy or borrow, and firm offers to sell or lend.
   d. Prices purchasers or rates borrowers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy or borrow, and prices sellers or rates lenders have expressed a willingness to offer, but for which Nuexco is not aware of firm offers to sell or lend.
2. Prices associated with deliveries under old or renegotiated contracts or other than arm's-length transactions are not considered in the determination of these Market Values.
3. In the determination of the Conversion Value, Nuexco does not consider transportation charges other than those customarily provided by primary suppliers of conversion services.
4. The prices of conversion services or SWUs delivered under long-term contracts with primary suppliers are not considered in the determination of either the Conversion Value or SWU Value.
5. For the DOE SWU Values, Nuexco converts SWU prices at varying tails and product assays to equivalent SWU prices at a tails assay of 0.30 weight-percent U_{235} and a product assay of 3.0 weight-percent U_{235}, assuming feed costs corresponding to the Nuexco Exchange and Conversion Values determined as of the same date.
6. In calculating the Transaction Value, Nuexco does not account for the price of uranium delivered in connection with contracts which call for "market price" mechanisms. This exclusion applies particularly to contracts in which delivery prices are expressed as a function of future Exchange Values or any other indeterminant variable. Also excluded from the calculation are any other transactions in which the delivery price is defined in such a way that it cannot currently be determined.

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CURRENT MARKET DATA

EXCHANGE VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	per lb. U_3O_8 in Concentrates			per kg. U in Concentrates		
	This Month (Oct. 31, 1984)	Last Month (Sept. 30, 1984)	12 Months Ago (Oct. 31, 1983)	This Month (Oct. 31, 1984)	Last Month (Sept. 30, 1984)	12 Months Ago (Oct. 31, 1983)
Australia (dollar)	18.90	20.96	25.60	49.14	54.49	66.55
Belgium (comm. franc)	984.62	1,072	1,228	2,560	2,786	3,192
Canada (dollar)	21.08	23.05	28.96	54.80	59.92	75.29
Finland (markka)	101.59	110.06	132.92	264.10	286.14	345.56
France (franc)	149.39	162.04	187.85	388.39	421.26	488.37
FRG (mark)	48.69	53.05	61.63	126.59	137.91	160.23
Italy (lira)	30,177	32,901	37,480	78,454	85,535	97,440
Japan (yen)	3,927	4,280	5,469	10,210	11,126	14,218
Netherlands (guilder)	54.91	59.50	69.10	142.75	154.70	179.64
South Africa (rand)	30.59	29.17	26.87	79.53	75.83	69.86
Spain (peseta)	2,736	2,959	3,571	7,113	7,693	9,285
Sweden (krona)	139.13	149.83	183.36	361.71	389.52	476.71
Switzerland (franc)	40.06	43.68	50.03	104.15	113.57	130.07
UK (pound)	13.18	14.05	15.71	34.26	36.52	40.84
US (dollar)	16.00	17.50	23.50	41.60	45.50	61.09

TRANSACTION VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	per lb. U_3O_8 in Concentrates			per kg. U in Concentrates		
	This Month (Oct. 31, 1984)	Last Month (Sept. 30, 1984)	12 Months Ago (Oct. 31, 1983)	This Month (Oct. 31, 1984)	Last Month (Sept. 30, 1984)	12 Months Ago (Oct. 31, 1983)
Australia (dollar)	18.96	19.82	25.76	49.29	51.53	66.98
Belgium (comm. franc)	987.69	1,013	1,236	2,568	2,635	3,212
Canada (dollar)	21.14	21.80	29.14	54.97	56.67	75.77
Finland (markka)	101.90	104.09	133.77	264.93	270.61	347.76
France (franc)	149.86	153.24	189.05	389.60	398.39	491.48
FRG (mark)	48.84	50.17	62.02	126.98	130.42	161.25
Italy (lira)	30,272	31,115	37,719	78,699	80,892	98,062
Japan (yen)	3,940	4,047	5,504	10,242	10,522	14,309
Netherlands (guilder)	55.08	56.27	69.54	143.19	146.30	180.78
South Africa (rand)	30.69	27.58	27.04	79.78	71.71	70.31
Spain (peseta)	2,745	2,798	3,594	7,135	7,275	9,344
Sweden (krona)	139.57	141.70	184.54	362.84	368.38	479.75
Switzerland (franc)	40.19	41.31	50.35	104.47	107.40	130.90
UK (pound)	13.22	13.29	15.81	34.37	34.54	41.10
US (dollar)	16.05	16.55	23.65	41.73	43.03	61.48

[1]Calculated using currency exchange rates published in the *Wall Street Journal* on October 31, 1984.

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CURRENT MARKET DATA

CONVERSION VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	per lb. U as UF_6			per kg. U as UF_6		
	This Month (Oct. 31, 1984)	Last Month (Sept. 30, 1984)	12 Months Ago (Oct. 31, 1983)	This Month (Oct. 31, 1984)	Last Month (Sept. 30, 1984)	12 Months Ago (Oct. 31, 1983)
Australia (dollar)	1.18	1.20	0.65	2.60	2.64	1.44
Belgium (comm. franc)	61.54	61.24	31.35	135.67	135.00	69.11
Canada (dollar)	1.32	1.32	0.74	2.90	2.90	1.63
Finland (markka)	6.35	6.29	3.39	14.00	13.87	7.48
France (franc)	9.34	9.26	4.80	20.58	20.41	10.57
FRG (mark)	3.04	3.03	1.57	6.71	6.68	3.47
Italy (lira)	1,886	1,880	956.94	4,158	4,145	2,110
Japan (yen)	245.46	244.56	139.63	541.14	539.16	307.84
Netherlands (guilder)	3.43	3.40	1.76	7.57	7.50	3.89
South Africa (rand)	1.91	1.67	0.69	4.22	3.67	1.51
Spain (peseta)	171.00	169.09	91.19	376.99	372.78	201.03
Sweden (krona)	8.70	8.56	4.68	19.17	18.88	10.32
Switzerland (franc)	2.50	2.50	1.28	5.52	5.50	2.82
UK (pound)	0.82	0.80	0.40	1.82	1.77	0.88
US (dollar)	1.00	1.00	0.60	2.20	2.20	1.32

SWU VALUES EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	DOE SWU FY85 (October 31, 1984)	Non-DOE SWU delivery within 15 months (October 31, 1984)	Non-DOE SWU calendar year 1986 (October 31, 1984)
Australia (dollar)	135.85	106.32	115.77
Belgium (comm. franc)	7,077	5,538	6,031
Canada (dollar)	151.50	118.56	129.10
Finland (markka)	730.16	571.43	622.22
France (franc)	1,074	840.34	915.03
FRG (mark)	349.97	273.89	298.23
Italy (lira)	216,899	169,747	184,836
Japan (yen)	28,228	22,091	20,055
Netherlands (guilder)	394.65	308.85	336.31
South Africa (rand)	219.89	172.08	187.38
Spain (peseta)	19,665	15,390	16,758
Sweden (krona)	1,000	782.61	852.17
Switzerland (franc)	287.93	225.34	245.37
UK (pound)	94.73	74.14	80.72
US (dollar)	115.00	90.00	98.00

[1]Calculated using currency exchange rates published in the *Wall Street Journal* on October 31, 1984.

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RECENT TRANSACTIONS[1], [2]

Uranium Sales

Nuexco Transaction Number	Delivery Period	Approximate Quantity (thousands of pounds, U_3O_8 equivalent)	Approximate Price as Percent of Current E.V.	Seller	Buyer	Remarks
3173	1984	50-100	104	R[2]	R[2]	UF_6.
3172B	1984	101-300	104	R[2]	R[2]	Contained in LEU.
3167	1984	less than 50	109	US Utility	US Producer	UF_6. Occurred in mid-1984.
3166	1984	101-300	104	US Utility	European Utility	UF_6. Occurred in mid-1984.
3162	1984	50-100	113	US Producer	US Utility	
3161	1984	101-300	113	Canadian Producer	European Utility	Occurred in mid-1984.
3160	1985	50-100	R[2]	R[2]	US Utility	
3153	1984	50-100	102	US Producer	R[2]	
3145	1985	101-300	see remarks	Canadian Producer	US Utility	Price related to market at time of delivery.
3144	1984	301-600	R[2]	Canadian Producer	US Utility	
3136	1984	50-100	98	US Utility	US Utility	UF_6. Assumes .30/lb. U for conversion component.

[1]Transactions listed are not limited to those in which Nuexco was involved, but also include others of which Nuexco is aware.
[2]The notation *R* means that Nuexco either does not know, or that Nuexco has restricted that information to protect client confidentiality.

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CURRENT MARKET DATA

RECENT TRANSACTIONS[1], [6] *(Cont.)*

Enrichment Services
Secondary Market Sales

Nuexco Transaction Number	Delivery Period[2]	Approximate Quantity[3] (thousands of SWUs)	Approximate Price[4] as Percent of Current SWU Value[5]	Seller Group	Buyer Group	SWU Origin	Remarks
3172A	FY85	less than 50	89	R[6]	R[6]	DOE	Contained in LEU.
3164	1985	less than 50	86	US Utility	US Utility	DOE	
3159	FY86	50-100	greater than 86 (see footnote 7)	R[6]	US Utility	DOE	
3142	FY87	101-300	R[6]	European Utility	US Utility	DOE	
3139	FY85	101-300	91	US Utility	US Utility	DOE	
3137	FY85	less than 50	91	US Utility	US Utility	DOE	
3135	FY84	less than 50	indeterminate	US Utility	US Utility	DOE	
3102	FY86	101-300	95	European Utility	US Utility	DOE	See footnote 5.

[1]Transactions listed are not limited to those in which Nuexco was involved, but also include others of which Nuexco is aware.
[2]Refers to calendar year, not fiscal year.
[3]If tails assay is unknown or unspecified, Nuexco's calculation of SWU quantity assumes 0.20 w/o tails assay.
[4]Price is not normalized to 0.20% tails assay.
[5]Refers to SWU Value that corresponds to SWUs included in transaction. When prices and SWU values are expressed as discounts (e.g., X dollars less than DOE's USEC base price at time of delivery), the percentage refers to the ratio of the *discounts*, not the ratio of the prices.
[6]The notation *R* means that Nuexco either does not know, or that Nuexco has restricted that information to protect client confidentiality.
[7]The discount in this transaction was greater than 86% of the current SWU value for DOE SWUs and FY86 delivery. See footnote 5.

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CURRENT MARKET DATA

URANIUM SUPPLY
(October 31, 1984)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U_3O_8) Spot or Near-term[2]	Intermediate or Long-term	Remarks
Available for Sale:			
ACTIVE			
1575	500	500 per year	
1860	400	1,500 per year	
2038	1,000	1,000 per year	UF_6
2288A*	40	—	
2288B*	295	—	UF_6
2389*	200	—	
2392	35	—	UF_6
2484	130	—	
2499	15	—	
2516	200	—	
2538*	35	—	
2574	500	—	UF_6
2588*	100	250 per year	1985-90
2648*	2,000	—	
2134*	—	220 per year	1985-87
2236	—	200 per year	1985-90
2263	—	500 per year	1985-90
TOTAL:	5,450		
INACTIVE			
2191	125	—	UF_6
2275*	150	—	
2335	275	—	
2495	130	—	UF_6
2509*	1,200	1,600	UF_6
2553	300	—	
0564	—	1,000 per year	1985-90
2193	—	800 per year	1986-90
2271	—	500 per year	1984-88
2297	—	200 per year	1986-89
2326	—	1,000 per year	1989-91
2336*	—	250 per year	
2368*	—	250 per year	1987-90
2473	—	500 per year	1984-90
2514	—	1,000 per year	
TOTAL:	2,180		

*New or revised since last month.
[1]Measured from the date of this Report.
[2]For delivery within one year. This category excludes material deliverable within one year under other than spot or near-term contracts.
Projects removed since last month: 2429, 2565.

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CURRENT MARKET DATA

URANIUM DEMAND
(October 31, 1984)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U_3O_8) Spot or Near-term[2]	Intermediate or Long-term	Remarks
Inquiries to Purchase:			
ACTIVE			
2563	800	—	UF_6
2590*	475	—	U_3O_8 or UF_6
2217	—	1,000 per year	1988-95
2442*	—	4,000	1986-95
2507*	—	600	1987-89
2555	—	150 per year	1986-91
TOTAL:	1,275		
INACTIVE			
2329	500	—	1985
2506	50	—	U_3O_8 or UF_6
2532*	70	—	
2576*	20	—	UF_6
1999	—	50 per year	1985-90
2244	—	350 per year	1987 on
2414	—	150 per year	1987-91
2457	—	350 per year	1988 on
TOTAL:	640		

*New or revised since last month.
[1]Measured from the date of this Report.
[2]For delivery within one year. This category excludes material deliverable within one year under other than spot or near-term contracts.
Projects removed since last month: 2419, 2528, 2542A.

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CONVERSION SUPPLY AND DEMAND
(October 31, 1984)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U as UF_6) Within 3 Years	Beyond 3 Years	Remarks
Available for Sale:			
ACTIVE			
2141*	1,000	—	
2560	225	—	
TOTAL:	1,225		
INACTIVE			
2051	1,000	—	
2438	500	250	1985-87
2511	600	700	1986-90
TOTAL:	2,100		

*New or revised since last month.
[1]Measured from the date of this Report.
Projects removed since last month: 2420.

No inquiries to purchase conversion this month.

LOAN SUPPLY AND DEMAND
(October 31, 1984)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U_3O_8) Within 1 Year	Beyond 1 Year	Remarks
Available for Loan:			
INACTIVE			
1938	2,000	—	UF_6
2128	700	—	
2139	2,000	—	
2469A*	800	—	
2483	550	—	
TOTAL:	6,050		

*New or revised since last month.
[1]Measured from the date of this Report.

No inquiries to borrow this month.

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CURRENT MARKET DATA

SWU SUPPLY
(October 31, 1984)

Nuexco Project Number	Delivery Period[1] (Thousands of SWUs) Spot or Near-term[2]	Intermediate or Long-term	Remarks
Available for Sale:			
ACTIVE			
2100*	150	100 per year	
2624*	500	—	
2285*	—	300	
2378*	—	120	1988
2408	—	65	1986
2510*	—	50	
2513*	—	25	1986
2517*	—	150	1986-89
TOTAL:	650		
INACTIVE			
2164*	80	—	
2359	180	—	
2580	150	—	
2583	50	—	
2589*	50	—	
2531	—	150	1987
2571	—	55	1987
TOTAL:	380		

*New or revised since last month.
[1]Measured from the date of this Report.
[2]For delivery within one year. This category excludes SWUs deliverable within one year under other than spot or near-term contracts.
Projects removed since last month: 2192, 2428.

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CURRENT MARKET DATA

SWU DEMAND
(October 31, 1984)

Nuexco Project Number	Delivery Period[1] (Thousands of SWUs) Spot or Near-term[2]	Intermediate or Long-term	Remarks
Inquiries to Purchase:			
ACTIVE			
2459*	30	—	
2480	100	—	
2604*	40	—	
2519	—	30 per year	1987 on
2578*	—	150	1986
2688*	—	40	1986
TOTAL:	170		
INACTIVE			
2500*	—	450	1987-90
2512	—	15 per year	1987 on
2543*	—	20	1986
2550*	—	50 per year	1986 on
TOTAL:	0		

*New or revised since last month.
[1]Measured from the date of this Report.
[2]For delivery within one year. This category excludes SWUs deliverable within one year under other than spot or near-term contracts.
Projects removed since last month: 2443, 2452, 2471, 2503, 2552, 2562, 2564, 2579.

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ANALYSIS & COMMENTARY

OPTIMUM TAILS ASSAY—Part 1

Introduction

An often-neglected variable in nuclear fuel management is the tails assay, the concentration of U_{235} in the waste stream of the enrichment process. The choice of tails assay can vary the cost of fuel by more than ten percent, but the selection of an optimum tails assay is not intuitively obvious; methods which worked in the past do not always apply to today's markets.

This is the first in a series of three articles on enriched uranium and the optimum tails assay. The first article covers the theory and economics of the enrichment process, how the cost of enriched uranium depends on the tails assay, and how to find the tails assay which gives the minimum product cost. The second installment will show how the tails assay for minimum cost changes for SWU prices that vary with tails assay, including the effects of the variable tails assay option (VTAO) surcharge and secondary SWU market transactions. The final essay will consider the optimum tails assay for utilities having feed in inventory which was purchased at relatively high prices, a question which confronts many utility fuel managers today.

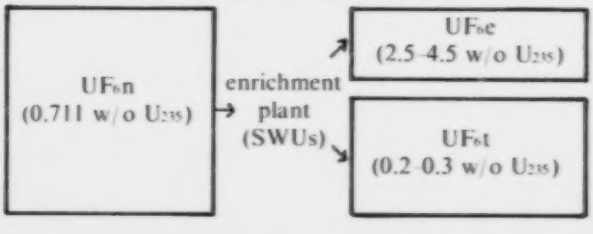
The Enrichment Process

Uranium neither depleted nor enriched in U_{235} is called natural uranium. The naturally occurring concentration (or assay) is 0.711 percent U_{235} by weight (w/o); an assay higher than that of natural uranium is also referred to as the enrichment level.

Most commercial applications of uranium require concentrations (enrichments) of 2 to 4 w/o in U_{235}. To increase the U_{235} assay of uranium (to enrich it), the uranium (feed material) is passed through a process which physically separates the U_{235} atoms from the more prevalent (and slightly heavier) U_{238} atoms. The enrichment process is not 100-percent efficient and eventually some waste material (the tails) with a small concentration of U_{235} must be disposed of.

Figure 1

THE ENRICHMENT PROCESS



The current diffusion and centrifuge enrichment processes use as feed material uranium in a gaseous form, uranium hexafluoride (UF_6). These processes are shown in schematic form in Figure 1.

The conservation of mass in the enrichment process is governed by the equation:

$$UF_6n = UF_6t + UF_6e$$

where UF_6n is the feed material, UF_6t is the tails stream, and UF_6e is the enriched product. The *Feed Factor*, or the quantity of feed required to obtain a unit quantity of enriched product is:

$$\frac{\text{Feed}}{\text{Product}} = \frac{[p - t]}{[f - t]}.$$

where f, p, and t are the assays of the product, feed, and tails stream. (See Appendix for derivation.)

For a given quantity of enriched product, the quantity of feed material varies with both product and tails assay. Figure 2 shows how feed material quantity is related to product assay in the enrichment process, while Figure 3 shows its relationship to tails assay. As the tails assay is increased, the quantity of feed material required increases, becoming infinitely large as the tails assay approaches the feed material assay.

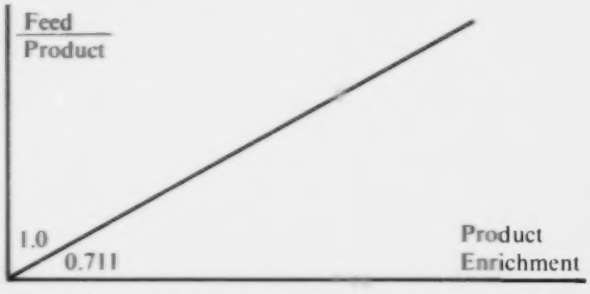


Figure 2. Quantity of Feed Material Required as a Function of Final Product Enrichment for a Fixed Tails Assay.

The enrichment process uses energy measured in Separative Work Units or SWUs. The number of SWUs required to obtain enriched product is a more complex function, because the separation process becomes more difficult as the separation between the product and waste stream increases (as the product enrichment increases or the tails assay decreases). The common units used for ura-

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nium hexafluoride feed and product material are kilograms of uranium (all isotopes), or KgU. In keeping with the units for the UF_6 product, the unit commonly used for SWUs is kilograms, sometimes referred to as Kg-SWU.

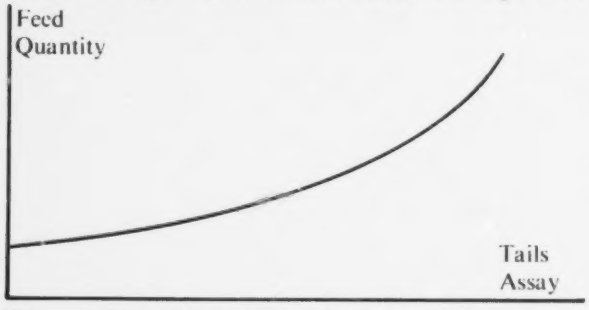

Figure 3. Feed Material Required as a Function of Tails Assays for a Fixed Quantity of Final Product at a Given Enrichment.

The required number of SWUs per KgU of product, or *SWU Factor,* is obtained by:

SWU Factor = V(p) - V(t) - Feed Factor × [V(f) - V(t)],

where V is the function:

$$V(y) = (2y - 1) \times \mathrm{Ln}[y/(1 - y)],$$

and f, p, and t are the assays of the feed, product, and tails streams.

The relationships of the required SWUs to product and tails assays are shown in Figures 4 and 5. The quantity of SWUs required is a non-linear function of the product enrichment, starting at zero for product enrichments of 0.711 w/o. The required quantity of SWUs declines as the tails assay is increased, but does not approach zero.

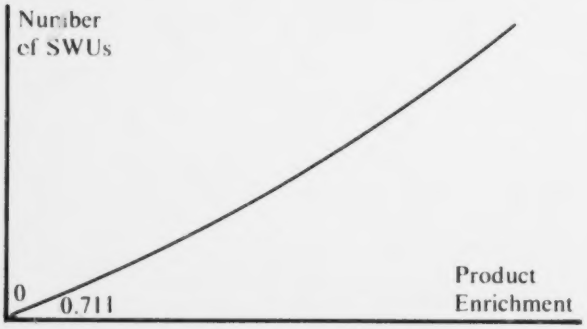

Figure 4. Number of SWUs Required as a Function of Product Enrichment for a Fixed Tails (Waste) Assay.

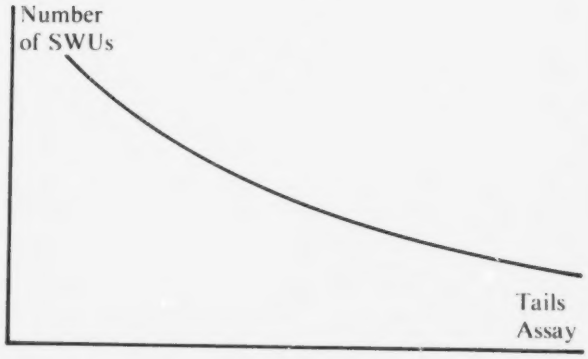

Figure 5. Number of SWUs Required as a Function of Tails Assay for a Fixed Quantity of Final Product at a Given Enrichment.

Product Cost

As seen from the foregoing relationship, a given quantity of enriched product at a given assay (concentration of U_{235}) may require a different quantity of feed material and a different number of applied SWUs, depending on the tails assay (concentration of U_{235} in the waste material) used. As a result, the unit cost (cost per KgU) of the enriched product, which is the sum of the cost of feed material and cost of applied SWUs, varies with the tails assay.

$$\text{Product Cost} = \text{Feed Cost} + \text{SWU Cost}$$

$$\text{or} = \begin{bmatrix}\text{Feed Factor} \\ \times \\ \text{Feed Unit Cost}\end{bmatrix} + \begin{bmatrix}\text{SWU Factor} \\ \times \\ \text{SWU Unit Cost.}\end{bmatrix}$$

At this point, the reader may be wondering why there is all this concern over the tails assay. After all, the tails assay is fixed at the enrichment plant, and it probably cannot be changed at the whim of every fuel manager. In reality, this is true for the *physical* tails assay, but there also can be a *transaction* tails assay other than the physical one.

All enrichment transactions, including those with the primary enrichment suppliers, actually exchange *feed material plus money* for *enriched product.* If the seller of enrichment services wants to sell the enriched product at a transaction tails assay different from the one at which it was produced or otherwise acquired, he will get more feed and less money in return at higher transaction tails, or vice versa at lower tails. Once the *transaction tails* is

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established, the amount of money and feed are determined by the price of the SWU and the theoretical Feed Factor and SWU Factor relationships given earlier.

For example, at times the USDOE has used a physical tails assay higher than its average transaction tails assay. This allowed the DOE to produce more enriched product per SWU from its enrichment plants at a time when it was concerned about having enough capacity. Operating at a higher tails assay required more feed material than DOE's customers were obliged to provide, so DOE furnished the difference from its own feed stockpile.

Optimum Tails Assay

Given that the tails assay is a variable, the important question is "which tails assay is best?". Past economic analyses of the enrichment process have focused on finding the tails assay that allows the minimum product cost, and usually have assumed that the unit feed and SWU costs are constants. With these assumptions, there are well-known techniques to evaluate the sensitivity of product cost to tails assay and to find a tails assay which yields the minimum product cost. Figure 6 shows the cost of UF_6 product enriched to 3.5 percent U_{235}, as a function of tails assay, for typical feed and enrichment costs of \$50/KgU and \$135/SWU.

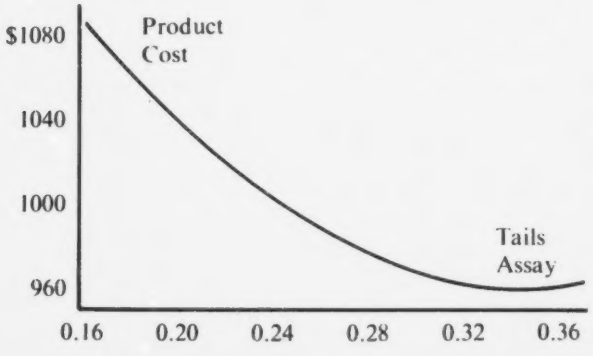

Figure 6. Cost of 3.50 w/o Product as a Function of Tails Assay for \$50/KgU Feed and \$135 SWU (Feed/SWU ratio = 0.37).

For the assumptions used in Figure 6, the product cost varies by about 15 percent in the range of tails assays available today, reaching a minimum at about 0.33 w/o. The tails assay for minimum product cost (using natural feed) is only dependent on the ratio of feed material unit cost to SWU cost. (It is not dependent on the enrichment level of the product.)

A method for finding the tails assay for minimum product cost is given in the Appendix. This tails assay is shown in Figure 7 as a function of the feed/SWU cost ratio. As expected, if the unit cost of feed rises in relation to the cost of a SWU, the minimum product cost is achieved by using a lower tails assay (less feed and more SWU).

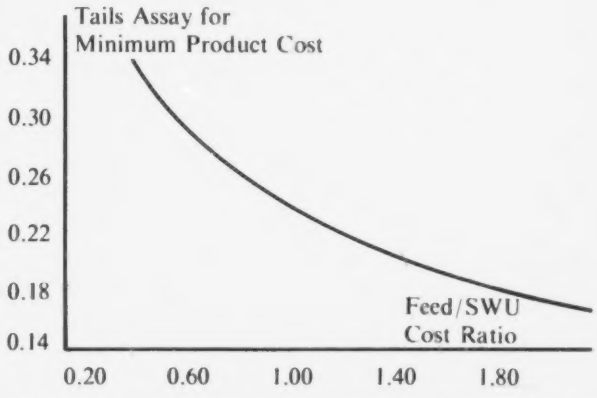

Figure 7. Tails Assay for Minimum Product Cost as a Function of the Feed/SWU Cost Ratio for Natural Uranium Feed.

Limitations

In the past, it was a commonly accepted principle that the tails assay shown in Figure 7 was the *optimum tails assay*. However, it is important to realize that the correct definition is *the tails assay for minimum product cost, assuming constant unit feed and SWU costs.* In the real world of uranium procurement, the assumptions used in deriving Figure 7 are usually not valid, and the minimum product cost may not always be the desired goal.

The true optimum tails assay is a function of the unique opportunities, constraints, and goals of individual utilities, and it is no longer intuitively obvious where the true optimum lies. The next essay in this series will discuss the ways in which variable unit SWU costs can affect the tails assay for minimum product cost, such as the VTAO surcharge and de-enrichment swap transactions. The final installment will show that the optimum tails assay is not necessarily that which gives the minimum product cost for a single batch of fuel. The immediate savings on one batch of enriched product may turn into added costs on subsequent future deliveries, thereby increasing overall costs. It also will discuss the optimum tails assay for other fuel management goals.

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APPENDIX

Derivation of the Feed Factor

The quantity of feed required to obtain enriched product is obtained from the equations of conservation for uranium and for U_{235} atoms:

$$\text{Feed (KgU)} = \text{Tails (KgU)} + \text{Product (KgU)}$$

and

$$U_{235}\text{ (feed)} = U_{235}\text{ (tails)} + U_{235}\text{ (product)}.$$

Expressing the number of U_{235} atoms as the weight of material times the weight-concentration of U_{235} (assay), the second equation becomes:

$$\text{Feed (KgU)} \times f = \text{Tails (KgU)} \times t + \text{Product (KgU)} \times p,$$

where f, p, and t are the assays of the feed, product, and tails (waste) streams.

Using the first conservation equation to express the quantity of tails material gives:

$$\text{Feed (KgU)} \times f = [\text{Feed (KgU)} - \text{Product (KgU)}] \times t + \text{Product (KgU)} \times p.$$

Solving for the quantity of feed per unit of enriched product:

$$\frac{\text{Feed (KgU)}}{\text{Product (KgU)}} = \frac{[p - t]}{[f - t]}$$

Tails Assay for Minimum Product Cost

The unit cost of enriched uranium is expressed as:

$$\text{Product Cost} = \text{Feed Factor} \times \text{Unit Feed Cost} + \text{SWU Factor} \times \text{Unit SWU Cost}.$$

The tails assay for the minimum product cost is found by taking the differential (slope) of this function with respect to the tails assay and setting it equal to zero. The resulting expression can be put to practical use in two ways. First, the equation can be solved explicitly for the feed/SWU cost ratio as a function of the optimum tails:

$$\text{Feed/SWU Cost} = V(f) - V(t) - C \times (f - t),$$

where

$$C = (2t - 1)/[t(1 - t)] + 2\text{Ln}[t/(1 - t)]$$

This equation can be graphed, and the graph used to find the inverse relationship.

As an alternative to the graphical solution, the following series of implicit equations can be solved by iteration on a computer or programmable calculator. In this series of equations, the feed is assumed to be 0.711 w/o, and the assays are also in units of weight-percent, in contrast to the other equations in this appendix, which use assay as weight fractions (weight-percent = weight fraction × 100).

$$A = (\text{Tails\%}/50 - 1) \times (0.711 - \text{Tails\%})$$

$$B = 4.868883 - (\text{Feed/SWU Cost}) + 0.985780 \times \text{Ln}[(\text{Tails\%}/(100 - \text{Tails\%})]$$

$$\text{Tails\%} = A \times 100/[(100 - \text{Tails\%}) \times B].$$

If the iteration is started with a tails assay of 0.20 w/o, the results are quite accurate within 5 iterations.

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RECENT DEVELOPMENTS

AUSTRALIA

The Australian government has agreed to buy 1,600,000 pounds U_3O_8 from Queensland Mines Ltd. (QML) over the next two years. The concentrates are part of a QML contract to supply 5,200,000 pounds U_3O_8 to Electricite de France (EDF). The material cannot be delivered because of the Australian government's ban on uranium shipments to France as long as it continues to conduct nuclear weapons testing in the South Pacific.

The government agreed to purchase each of the next eight shipments at the original delivery price. Based on the Australian floor price of approximately $31, QML's compensation would approach US$50,000,000 over the next two years. The agreement requires the company to repay the government if it sells the material to another buyer. The quarterly shipments purchased by the government will run through September 1986 and will increase the Australian government's stockpile by 30 percent, to more than 5,000,000 pounds U_3O_8.

The purchase relieves the Australian Labor Party (ALP) of pressure from the uranium producers for the time being, until new arrangements can be made concerning Australia's uranium exporting policies. The next ALP policy conference is scheduled for mid-1986. Limiting the compensation agreement to two years implies that some strategists hope for a relaxation of the ban at the 1986 conference. The ban might be lifted by then, or the French might have discontinued weapons testing. However, a total of about 3,200,000 pounds U_3O_8 remains to be delivered, so unless the situation changes by then, the government could come under renewed pressure to make a second purchase equal to the first, thereby accounting for the entire undelivered supply.

Electricite de France has made no comment on the deal. In September, EDF agreed to suspend the contract with QML. Without EDF's consent, QML would have had to declare force majeure or become liable for breach of contract. There is sufficient uranium on the spot market, at lower prices, to cover EDF's present needs, and it appears that France would like to maintain good relations with a major supplier.

* * *

Energy Resources of Australia's ownership changed when North Broken Hill Holdings, Ltd. replaced one of ERA's original shareholders, EZ Industries (31 percent) in a successful takeover. Other ownership percentages were not affected. The current ownership structure of ERA is shown in Table 2.

Table 2

ENERGY RESOURCES OF AUSTRALIA OWNERSHIP

Company	Percent Share
North Broken Hill Holdings, Ltd.[1]	30.96
PEKO-Wallsend Operations, Ltd.	30.96
Australian public	13.08
Japan Australia Uranium Resources Development Company, Ltd.	10.00
Rheinische Braunkohlenwerke AG[2]	6.25
Urangesellschaft Australia Pty. Ltd.	4.00
Badenwerke AG	2.50
Saarberg-Interplan Uran	1.25
Oskarshamnverkets Kraftgrupp AG (OKG)	1.00
	100.00

[1] Acquired Electrolytic Zinc Company of Australasia, Ltd.
[2] A subsidiary of Rheinisch-Westfaelisches Elektreizitaetswerk AG (RWE).

* * *

The feasibility study for the development of the Olympic Dam project (Roxby Downs) undertaken jointly by Western Mining (WMC) and BP Australia will cost A$150 million, with an expenditure to date of A$71.5 million. The joint venture partners have struck a new arrangement for the funding of the study. Western Mining will fund 51 percent of the future expenditure, while BP will pay for the expenditure to date plus 49 percent of the remainder. WMC's contribution amounts to A$40 million.

The joint venture partners have been issued determinations under the government floor price system. These allow them individually to enter into negotiations with potential customers. When applying for determinations, companies submit both the names of potential customers and approximate quantities, which become the basis for government approval.

The project is likely to proceed in stages, depending on feasibility and market conditions. To make it viable, uranium sales of 2.5 million pounds per year would be needed

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initially, in addition to an adequate market niche for the copper production. The partners, even in the face of a gloomy market outlook, are still hopeful of launching the project in the 1980s.

SOUTH AFRICA

Third-quarter production from Chamber of Mines producers amounted to approximately 3,500,000 pounds U_3O_8, down slightly from the level of 3,800,000 pounds produced in the second quarter of 1984 and the level of 3,850,000 pounds produced in the first quarter of the year (Table 3). The 7-3-percent decline from the second quarter production can be attributed to the following factors:

1. The cessation of mining operations and the completion of underground reclamation at the Beisa (St. Helena) operation caused a 68-percent drop in production.

2. A 14-percent drop in tons of ore treated at the Dreifontein Consolidated operation resulted in a 15-percent drop in production there.

3. Lower uranium ore grades accounted for a 24-percent drop in production at East Rand Gold and Uranium Co. Ltd. (ERGO).

These losses were partially offset by normal fluctuations in tons of ore treated, and several operations reported small gains in production. JMS (Free State Joint Metallurgical Scheme) reported an increase in production of 10 percent, and Harmony reported a 5-percent increase. Despite that small increase, Harmony is slowing its U_3O_8 production because of the company's view of a heavily overstocked market. To avoid the buildup of excessive stockpiles, Harmony reduced the amount of slimes processed for uranium recovery to 6.65 million metric tons from 7.29 million metric tons.

Due to the conclusion of mining operations at the Beisa operation, and the slowdown of Harmony production, Nuexco's forecast of 1984 output from Chamber of Mines producers amounts to approximately 14,500,000 pounds U_3O_8.

* * *

Table 3

REPUBLIC OF SOUTH AFRICA:
1984 URANIUM PRODUCTION[1]
(Thousands of pounds U_3O_8)

Operation	First Quarter 1984	Second Quarter 1984	Third Quarter 1984	Year to Date
Beisa (St. Helena)[2]	338	333	107	778
Blyvooruitzicht	155	132	142	429
Buffelsfontein	313	331	337	981
Chemwes (Stilfontein)	310	279	290	879
Dreifontein Consolidated	98	104	88	290
ERGO[3]	113	94	71	278
Harmony	307	259	274	840
Hartebeestfontein	248	253	225	726
JMS[4]	356	265	293	914
Randfontein	287	361	361	1,009
Vaal Reefs	1,069	1,129	1,078	3,276
Western Areas	175	171	164	510
Western Deep Levels	79	82	83	244
TOTAL	3,848	3,793	3,513	11,154

[1]Excludes Palabora Mining Company, which is not a member of the Chamber of Mines.
[2]Mining operations ceased and underground reclamation completed.
[3]ERGO = East Rand Gold and Uranium Co. Ltd.
[4]JMS = Free State Joint Metallurgical Scheme.

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RECENT DEVELOPMENTS

Palabora Mining Company reported sales of about 502,000 pounds U_3O_8 during the first six months of 1984. That figure represents a 29-percent increase over the 356,000 pounds U_3O_8 sold in the first half of 1983. The company has no further uranium concentrate sales scheduled for the remainder of 1984.

UNITED STATES

The Energy Information Administration (EIA) has released information on uranium production and resources in the USA in 1983. Production of uranium concentrates fell 21 percent in 1983 to 21.2 million pounds, down from 26.9 million pounds in 1982. Before processing, with the usual recovery loss of about five percent, uranium contained in mined ore totalled 23.5 million pounds in 1983, a 12-percent decline as compared to 26.8 million pounds in 1982. Of the 23.5 million pounds extracted in 1983, 18.6 million pounds (79 percent) were contained in uranium-bearing ore mined by conventional (open-pit and underground) mining methods. The average grade was 0.126 percent. The remainder was extracted from mine dumps, mill tailings, heap leaching, in-situ leaching, mine water, and as a byproduct of phosphate and copper mining. More than half of the uranium extracted came from Wyoming and New Mexico.

The EIA also reported estimates for reasonably assured resources (RAR) and estimated additional resources (EAR) for the USA. The three categories for RAR (Lower, Medium and Higher Cost) contain an estimated total of 1.79 billion pounds of RAR (Table 4).

Nuexco production forecasts for 1983 anticipated a decline in production to 20.6 million pounds U_3O_8 (Report 186), 600,000 pounds less than the EIA figure. Expecting that decline to continue, Nuexco's current forecast of uranium production anticipates US output to amount to approximately 16,000,000 pounds U_3O_8 in 1984.

CORRECTION

In the Annual Update on Taiwan in Report 193 (September 1984), Nuexco reported that Taipower receives its uranium supply from African, Australian, and US producers. In actuality, only African and US producers supply Taipower's uranium requirements. Because the Australian government does not recognize Taiwan, and no bilateral safeguards agreement exists between the two countries, no Australian producer would be able to obtain approval to supply Taiwan under current conditions.

Table 4

US URANIUM REASONABLY ASSURED RESOURCES (RAR)
(On December 31, 1983)[1]

Forward Cost Category	Tons of Ore (millions)	Average Grade (percent U_3O_8)	Contained U_3O_8 (million pounds)
Lower (less than \$30/lb. U_3O_8)	86	0.21	360
Medium (\$30–\$50/lb. U_3O_8)	492	0.08	780
Higher (\$50–\$100/lb. U_3O_8)	819	0.04	630

[1]Source: US Department of Energy, Grand Junction Area Office.

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EXCHANGE AND TRANSACTION VALUES
SINCE JANUARY 1979
Determined as of the last day of the month indicated

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HISTORICAL MARKET DATA

HISTORICAL EXCHANGE VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	—	—	—	—	—	—	—	6.35	6.35	6.40	6.45	6.50
1969	—	6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	32.50	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20	41.00	40.75
1980	40.00	38.00	35.00	32.00	32.00	31.50	31.50	30.00	28.50	28.00	28.00	27.00
1981	25.00	25.00	25.00	25.00	25.00	24.25	23.50	23.50	23.50	23.50	23.50	23.50
1982	23.00	23.00	22.50	20.75	20.50	19.25	18.25	17.00	17.00	17.50	19.75	20.25
1983	21.50	21.75	22.25	23.25	23.50	23.50	24.00	24.00	24.00	23.50	22.50	22.00
1984	20.50	17.50	17.00	17.75	17.75	17.50	17.50	17.50	17.50	**16.00**		

HISTORICAL TRANSACTION VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	—	—	—	—	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60	43.50	42.30
1980	42.00	39.30	38.60	38.40	37.90	37.60	37.30	31.60	30.60	29.00	28.70	27.70
1981	27.20	27.20	27.00	25.70	25.70	24.50	24.40	24.30	23.90	24.10	24.10	24.00
1982	24.00	23.70	23.40	22.60	22.70	21.50	20.30	19.10	17.30	17.00	17.55	18.80
1983	19.35	20.00	21.35	21.40	22.35	22.45	23.50	23.60	23.65	23.65	23.85	23.85
1984	23.05	22.50	19.25	17.90	17.00	16.50	16.60	16.40	16.55	**16.05**		

HISTORICAL CONVERSION VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U as UF_6)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1981	1.20	1.20	1.20	1.40	1.15	1.15	1.15	1.10	1.10	1.10	1.20	1.20
1982	1.20	1.20	1.20	1.20	1.00	1.00	1.00	0.90	1.10	1.60	1.45	1.45
1983	1.20	1.40	1.40	1.20	1.20	1.20	1.10	1.10	1.00	0.60	0.60	0.60
1984	0.60	0.30	0.80	0.80	0.80	0.00	0.00	0.80	1.00	**1.00**		

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AUSTRALIA

GOVERNMENT STATISTICS

	Price Index of Materials Used in Manufacturing Industry—All Groups[1] (1969=100)	Award Rates of Pay Indexes Australia—Adult Males In Mining Wage and Salary Earners, Weekly Rates[2] (1976=100)
1983 Avg.	401.2	181.8
Jul 1983	408.3	180.7
Aug 1983	403.0	180.7
Sep 1983	402.9	180.6
Oct 1983	397.5	188.3
Nov 1983	395.5	188.3
Dec 1983	399.2	188.1
Jan 1984	399.1	188.3
Feb 1984	402.4	188.2
Mar 1984	403.8	188.0
Apr 1984	404.1	195.8
May 1984	403.7	196.6
Jun 1984	404.8	196.6
Jul 1984	408.3	196.6
Aug 1984	408.3	196.6

P = Preliminary R = Revised since last month

CANADA

	Industry Selling Price Index: Manufacturing[1] (1971=100)	Wage-earner Data: Average Hourly Earnings (C$)[2] Uranium Mines (SIC 057)	Metal Mines* (SIC 051-059)	Mines, Quarries and Oil Wells[3] (SIC 051-099)	Primary Metal Industries Non-ferrous[4] (SIC 296)	(SIC 298)	Chemicals and Chemical Products[5] (SIC 372-379)
1983 Avg.	298.8	—	—**	14.30	—	—	11.17
Aug 1983	301.3	16.93	14.36	13.89	11.82	10.08	11.19
Sep 1983	301.1	17.66	14.90	14.41	11.99	10.32	11.29
Oct 1983	301.6	17.73	15.27	14.65	11.76	10.03	11.30
Nov 1983	301.8	17.82	15.29	14.67	11.78	10.62	11.38
Dec 1983	302.9	17.84	15.11	14.66	11.86	10.60	11.51
Jan 1984	305.4	17.74	15.27	14.74	11.91	10.84	11.69
Feb 1984	306.6	17.78	15.59	14.90	12.04	10.82	11.51
Mar 1984	308.7	18.05	15.52	14.82	12.14	10.84	11.58
Apr 1984	310.5	18.06	15.83	15.10	11.96	10.34	11.63
May 1984	310.6	18.48	15.64	15.06	12.11	10.16	11.65
Jun 1984	311.0	18.08	15.48	14.80	12.38	10.40	11.66
Jul 1984	312.6R	17.81R	15.72R	14.92R	12.53R	10.18	11.82R
Aug 1984	312.5R	17.24P	15.44P	14.86P	12.31P	10.31P	11.87P
Sep 1984	312.0P	—	—	—	—	—	—

P = Preliminary R = Revised since last month

For annual averages prior to 1983, and for notes pertaining to these statistics, see pages 23-26 of Report 190 of June 1984.

*The 1980 average for Metal Mines was incorrectly reported as 10.59. The correct average is 10.58 (see Report 190).

**Two different methods were used in the 1983 "Metal Mines" category in reporting survey data, and Statistics Canada did not publish a 1983 average. The March 1983 figure for the old method was 14.73 and for the new method was 14.84. The published average for 1983 in Report 190 was a Nuexco calculation based on the available monthly statistics for 1983 with the exception of the March figure, where only the 14.84 value was taken into account.

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GOVERNMENT STATISTICS

REPUBLIC OF SOUTH AFRICA

	Average Declared Working Costs per per Metric Ton of Gold Ore Milled (Rand)[1]	Tonnage-Weighted Index of Average Working Costs per Metric Ton of Gold Ore Milled (March 1982=100)[2]	Consumer Price Index[3] (1975=100)[4]	Producer Price Index All Groups[5] (1975=100)	Total Employment in Mining and Quarrying (Code 35)[6]	Total Salaries and Wages in Mining and Quarrying (1,000 Rand) (Code 40)[6]
1983 Avg.	51.87	115.0	262.2	274.8	696,579	3,644,772
Aug 1983	—	—	265.6	278.9	698,984	311,789
Sep 1983	52.92	117.4	267.3	279.4	696,435	312,264
Oct 1983	—	—	270.0	281.0	693,225	311,418
Nov 1983	—	—	271.4	281.6	688,459	317,485
Dec 1983	53.70	119.6	273.2	283.7	690,750	333,595
Jan 1984	—	—	274.7	283.3	689,807	326,619
Feb 1984	—	—	278.4	286.5	702,553	335,906
Mar 1984	55.30	123.1	281.9	288.0	715,628	342,332
Apr 1984	—	—	286.1	290.2	712,963	327,550
May 1984	—	—	288.3	292.6	710,040	327,937
Jun 1984	56.95	126.2	291.2	295.3	717,009	347,121
Jul 1984	—	—	295.1	296.0	717,121	369,964
Aug 1984	—	—	297.0	300.8	—	—
Sep 1984	—	—	299.9	—	—	—

UNITED STATES

	Producer Price Index[1]		Consumer Price Index[2]	GNP Implicit Price Deflator[3]	Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$)[4]			
	Industrial Commodities (1967=100)	All Commodities (1967=100)	(1967=100)	(1972=100)	Metal Mining (SIC 10)	Primary Non-ferrous Metals (SIC 333)	Chemicals and Allied Products (SIC 28)	Electric and Electronic Equipment (SIC 36)
1983 Avg.	315.8	303.1	298.4	215.63	12.57	13.43	10.59	8.65
Aug 1983	317.3	304.7	300.3	—	12.54	13.46	10.62	8.62
Sep 1983	317.1	305.3	301.8	216.44	12.62	13.46	10.70	8.73
Oct 1983	318.5	306.0	302.6	—	12.67	13.55	10.79	8.71
Nov 1983	318.3	305.5	303.1	—	12.64	13.56	10.86	8.77
Dec 1983	318.4	306.1	303.5	218.53	12.75	13.33	10.90	8.84
Jan 1984	319.1	308.0	305.2	—	12.67	13.38	10.91	8.88
Feb 1984	320.6	308.9	306.6	—	12.81	13.34	10.90	8.86
Mar 1984	321.9	311.0	307.3	220.58	12.85	13.33	10.95	8.88
Apr 1984	322.5	311.4	308.8	—	12.91	13.30	10.97	8.89
May 1984	323.3	311.7	309.7	—	12.99	13.37	11.02	8.89
Jun 1984	323.9	311.4	310.7	222.40	12.96	13.40	11.03	8.91
Jul 1984	324.0	312.0	311.7	—	13.02R	13.36	11.12R	8.95
Aug 1984	323.5	310.9	313.0	—	13.07P	13.52P	11.12R	9.00R
Sep 1984	322.3	309.5	314.5	224.36	—	—	11.19P	9.08P

P = Preliminary R = Revised since last month

For annual averages prior to 1983, and for notes pertaining to these statistics, see pages 23-26 of Report 190 of June 1984.

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